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ACTIVE LEARNING VERSUS PASSIVE LEARNING: CAN BOTH WORK TOGETHER? FOR US, THEY CAN

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ABSTRACT

The use of theoretical classes that contextualize physiological concepts, followed by active methodologies has been common practice in our physiology classes.We employed active learning techniques in the medical course that involved physiology contents. We use brainstorming followed by conceptual maps, question-and-answer games, dramas, memory games, puzzle and portfolio creation.The goal of this assignment was to evaluate the active and passive methodologies in our educational context and to present a memory game – as active methodology - to explain the mechanisms of the electrical and chemical synapses.The game consisted of 2 boards and 40 foam pieces. The boards: one meant for electrical synapses and the other for chemical synapses, were divided into two columns to be fitted by the pieces: characteristics and the order of synaptic physiological events. The players were divided into two (n = 10) groups, one (n = 5) for each type of synapse. One player from each team chose two pieces simultaneously andthey were placed on the corresponding board.This procedure was repeated until one of the groups had filled the board with all the pieces related to the physiological characteristics of the synapses and to the sequences of synaptic events.At the end of the activity, it was concluded that learning the synaptic mechanisms through a playful process was more pleasant and fun compared to theoretical classes only and when strategically applied, active learning and passive learning are useful for teaching and for the learning process of medical school students.

KEYWORDS: active learning; educational game; active methodology; physiology.

INTRODUCTION

Many studies have indicated that active forms of learning are more effective than the traditional lecture, which is considered to be a more passive form of learning (Bowen, 2000; Barkley et al., 2005; Knight and Wood, 2005; Armbruster et al., 2009). In particular, the advantages of active learning have been emphasized with regard to conceptual understanding (Barr and Tagg, 1995; Smith et al., 2005; Armbruster et al., 2009). Moreover, relative to passive learning, active learning approaches, especially cooperative ones, have been associated with a great number of positive effects. Some of these desirable effects include: increased student engagement (Lord, 2001; Smith et al., 2005; Armbruster et al., 2009), elevated self-belief and improved self-perceived competence (Lord, 2001; Smith et al., 2005).

Active versus passive learning is not a simple dichotomy: a common factor in most articles on active learning is the suggestion that the traditional didactic lecture is more passive in nature and less effective as a teaching tool compared with active learning methods, such as problem-based learning (PBL). However, a well-organized lecture remains one of the most effective ways to integrate and present information from multiple sources on complex topics, such as those often encountered in the teaching of physiology (Richardson, 2008).

Richardson (2008) has described some things that he has found instructors can do to make lecture-based courses more engaging to students: 1) Carefully scrutinize your lectures for the concepts you want the students to learn and then eliminate details that are not really necessary for the understanding of these concepts. This should help your students to focus on the concepts as well as shorten your lectures, giving you a bit of class time to do other things, such as an active learning exercise. 2) Once you have settled on details, do not spell out every one of them in a handout. Leave the space and opportunity for the students to take a few notes. Even writing down a word or two here and there helps students to stay engaged. 3) Whenever and wherever possible, use real life examples that the students are familiar with and that are relevant in today's society. This fits into the schema theory of learning, which basically says that new knowledge is built on a foundation of existing knowledge. When using clinical cases as examples, pick ones that your students are likely to encounter. 4) In the relevant category, add a few tidbits into your lecture from what has been called the recondite curriculum (Hansen, 2002). This curriculum comprises the social and behavioral correlates of physiology. Students typically show great interest in such items, and they can help to keep the levels of student engagement high. 5) Do something different approximately every 20 minutes during class to “break the monotony” of lecturing. This could be as simple as having the students stand up and stretch, or having them engage in one of several brief active learning exercises that can be performed in a lecture setting (Myers and Jones, 1993; Angelo and Cross, 1993).

Pedersen and Liu (2003) note that student-centered is usually defined in opposition to teacher-centered, and Barr and Tagg (1995) have discussed a change in the educational paradigm from one that focuses on teaching to one that focuses on learning. A conventional lecture-based course is said to be teacher-centered because of the view that what matters most in determining what is learned is what the teacher does in the lecture hall. It is understood that what the students do in response to the teacher's lecture matters, but the focus is on the teacher in the front of the classroom. A student-centered learning environment is one in which the attention is on what the students are doing, and it is the students' behavior that is the most significant determinant of what is learned. It is acknowledged that what the teacher does matters greatly, but the attention here is firmly on the students; because, after all, it is the teacher who designs and implements the learning environment (Michael, 2006).

Michael and Modell (2003) have described what it is that the students should be doing in a typical student-centered active learning environment. They described the process as building mental models of whatever is being learned, consciously and deliberately testing those models to determine whether they work, and then repairing the models that appear to be faulty. Students learning in this way are more likely to be achieving meaningful learning (Ausable, 1963; Dolmans and Schmidt, 1996; Michael, 2004).

PBL has been a useful and increasingly applied educational method since 1969 because of its benefits (Cole, 1985; Elliot, 1999). This educational method allows the student to acquire case-specific problem-solving skills and the ability to apply their own previous knowledge and gain new information while solving problems using critical thinking skills. Thus, it allows the student to relate the new information to his or her own previous knowledge while learning, and it enhances independent learning skills over time (Gurpinar et al., 2013). The knowledge gained in an independent study period could be consolidated in small group discussions (Blumberg and Michael,1992; Dolmans and Schmidt, 1996). Consequently, PBL methodology is naturally expected to influence meaningful, comprehensive, and deep learning on the basis of higher cognitive skill and collaborative learning actions in small groups.

As scientists, we have been trained to make decisions based on evidence, and it is appropriate to ask for evidence that these proposed new approaches to teaching and learning, these reforms, work any better than the old approaches from which we all learned and from which our students seem to be learning. The short answer is that there is evidence to support the claims made by advocates of reform (Michael, 2006). Like any of the scientific fields with which we are most familiar, educational research is generating an ever-growing data base, and it is becoming increasing difficult to keep up with the literature.

Active learning works. It is clear that there are large bodies of evidence from a number of different fields supporting the effectiveness of active learning. How applicable is the evidence? It is important to recognize that while learning physiology has many important similarities with learning physics (or anatomy), there are also important differences that are the consequence of the significant differences between the various science disciplines. Thus, it would be unreasonable to expect that the results from education research involving students very different from your students learning a discipline different than your discipline will translate into a recipe for how you should teach in your classroom. But, the mass of accumulating evidence for all grade levels and disciplines certainly should be

used to guide your decision-making process regarding how to best help your students learn your discipline (Michael, 2006).

Evaluation of the active and passive methodologies in our educational context

In Brazil, we live in a complex educational reality. When deciding on a university, our students prefer to attend public institutions - both federal and state - over private institutions. The admission process for such public universities is very competitive. There are college preparatory courses to help students in this process. Thus, our high school program, tends to strongly concentrate its studies on subjects very likely to be evaluated in the admission tests for public universities admission. Unfortunately, the methodology used by many teachers, especially those who teach the preparatory courses, is based on memorization only.

In the last few years, the number of educational organizations has grown exponentially in Brazil. According to data from the INEP (Anísio Teixeira Educational Studies and Research National Institute), presented during the III Educational Census National Meeting, held in 2013 in the city of Foz do Iguaçu, Paraná State, Brazil, there are currently 2,416 Higher Education Institutions, with 31,866 undergraduate courses, where 7,037,959 students are enrolled, from which 1,050,413 have completed their courses. In the Southeast part of the country, where our institution is located, there are 1,030 private education institutions. Data from the Brazilian Federal Medical Council, in 2014, show that there are 30 school of medicine in the São Paulo state (9 public schools and 21 private schools). Data regarding the investments in education between 1998 and 1999, show that 0.9% of the GDP (Gross Domestic Product) was invested in higher education (undergraduate and graduate programs), 0.5% was invested in high school programs and 2.5% in middle school programs (SPO/MEC, 2001). Almost all of these investments went toward public education.

In Brazil, public high education institutions aim at education, research and extension. However, in the great majority of such institutions, particularly the ones located in the Southeast of Brazil, research gamers greater attention than education. Some groups have been discussing strategies to achieve a more balanced relationship between the quality of education and the research activities in these institutions. For the last three years, the Undergraduate Education Committee of the Brazilian Society of Physiology (SBFis) has been promoting workshops to discuss teaching methodologies for physiology courses. These meetings show a growing attendance by undergraduate and graduate students and teachers from public and private universities from all over Brazil. In addition to SBFis, FESBE (The Federation for Experimental Biology Societies) has been annually offering, for over ten years, undergraduate workshops with the goal of motivating discussions regarding the methods through which we teach physiology to our undergraduate and graduate students.

In most private institutions research is not the objective envisaged in their own regimens, except for private universities. There are differences between a university and a university center in Brazil. The focal point of the university centers is education, and the teachers do not have any high level scientific research activity due to a considerable deficiency in financial investments to foment such research programs. Except for when partnerships are established between teachers from private institutions and researches from public institutions, generally, there is no research.

Given this context, our reality is outlined by students who normally could not enroll into a public institution, making private institutions their second choice; they pay tuition that, because it is very expensive, restricts the number of students who can actually afford to enroll in a medical school undergraduate course. The students become anxious about the possibility of taking part in the scientific programs, as previously mentioned, are very modest when they do exist at all. Thus, these students are not used to the rigorous studying necessary at a medical school course and they expect the teaching-learning methodologies applied by the university to be different than the ones they had experienced up until that time. The use of a modified concept mapping tool was applied to more holistically investigate students' perceptions of how their beliefs, values, and attitudes are connected to the cognitive, psychomotor, and affective domains of learning (McNaughton et al., 2016).

Amid this environment, which methodology should be applied: active learning or passive learning? It is not a simple answer, nor is it exclusive; there is no need to choose only one methodology at the expense of the other.

In our institution (Barão of Mauá University Center), human physiology for undergraduate courses in medicine is taught with care to ensure the continual participation of students during theoretical and practical lessons. Students are advised on the care that they should demonstrate during practical lessons with experimental animals and enlightened about the importance of using videos and computerized models as a substitute for animal models when possible. Students are also consistently encouraged to develop creative methods of presenting the contents discussed during theory lessons. The course on physiology offered to undergraduate medical students occurs in the second and third semesters of the school year.

As previously explained, we receive students from preparatory courses that prioritize memorization: we need to change this learning method. Moreover, there is one more aggravating factor, namely, dealing with the students' emotional states, because most of them face the reality of living away from their families for the first time. Added to all this, the physiology course at our institution is taught from the first year on of medical school, and it is known as a complex course. Therefore, it is not just a matter of choosing one teaching methodology but also using strategies that allow for extracting the best out of each methodology - active and passive learning - based on what they have to offer to meet the needs of teachers and students.

For over five years, the physiology course offered to medical students at our institution has been employing the use of active learning in association with passive learning, especially lecture-based learning (Montrezor, 2014). Using both methodologies has been well accepted by students when they are used in a complementary manner. As suggested by Richardson (2008), the use of practical examples can associate the content acquired to the day-to-day life of the students. Additionally, problem-solving based on clinical cases that can be seen by students at the school hospital are all routine practice at our course of physiology for students of medical school. Additionally, encouraging students to be able to create, discuss and share with their classmates some learning tools concerning the content of the physiology course after theoretical classes is very productive. Therefore, the use of theoretical classes that contextualize physiological concepts, followed by active methodologies has been common practice in our physiology classes for medical students.

Memory game as an active learning methodology

We employed active learning techniques in the physiology course that involved all of the classic contents of the nervous, endocrine, cardiovascular, respiratory, renal, digestive and reproductive systems. We initially use brainstorming followed by conceptual maps, question-and-answer games, dramas, memory games, puzzles (Marcondes et al., 2015) and portfolio creation (Montrezor et al., 2016), as week as other activities such as seminars and practical classes using computer simulations. Usually, physiology concepts are presented through lectures before the activities that employ active learning. During these lectures, which last on average 50 minutes, discussions between the teacher and the students and among the students are frequently encouraged.

Our classes are attended solely by medical school undergraduates with, on average, 60 students. These activities are performed in groups, usually with five people each. The time available for students to prepare their activities is established according to the content to be studied. Usually, students work for approximately 15 days to build their learning tools. The work is performed during studying time assigned in their schedule and outside of the theoretical classes. The presentations take place in the classroom, during physiology classes, and they last nearly 15 minutes (for each group). Once the presentations are complete, discussions are held so all of those who are interested in sharing their experiences in building the tools can do so, and also can discuss the content of the presentations. The group work has been well accepted by the students in our course (Montrezor, 2014).

One example of a tool recently built by a group of students is a memory game. The goal of this assignment was to present a memory game to explain the mechanisms of the electrical and chemical synapses as well as to stimulate active participation of students in the teaching-learning process. The game consisted of 2 boards (A3 sheet -42 x 29.7cm) and 30 foam pieces (6 x 3 x 2cm). The boards: one meant for electrical synapses and the other for chemical synapses, were divided into two columns to be fitted by the pieces: characteristics (15 pieces) and the order of synaptic physiological events (15 pieces). The players were divided into two (n = 10) groups, one (n = 5) for each type of synapse. The pieces were mixed together at the beginning of the game. One player from each team chose two pieces simultaneously. If both pieces were related to the same type of synapse, they were then placed on the corresponding board; if not related to the same type of synapse, the pieces were put back on the table. This procedure was repeated until one of the groups had filled the board with all the pieces related to the physiological characteristics of the synapses and to the sequences of synaptic events. Later, the positions of all pieces on the board were evaluated. The group that had correctly placed the characteristics and sequences of the synaptic physiological events was considered the winner. The competition during the game was not encouraged that the goal was kept in the learning process. At the end of the activity, it was concluded that learning the synaptic mechanisms through a playful process - a game - was more pleasant and fun compared to theoretical classes only.For 98% of students (n = 58), the use of the memory game as an active methodology was positive for the learning process. However, studying and comprehending the proposed theme prior to organizing the game was fundamental.

FINAL CONSIDERATIONS

The teaching of physiology is indispensable in many biological and health disciplines. Physiology is one of the major components of the curriculum in a number of life sciences courses, including the study of life, cells, tissues, and organisms, both in terms of structure and function (Lin et al., 2012). A bigger challenge for physiology teachers is to make physiological concepts attractive to students, particularly medical students. The health professional, especially, needs a foundation of contextualized learning that does not compromise quality, in order to make the coursework more meaningful to them (Borges and Mello-Carpes, 2012).This foundation depends on student-centered teaching together with tradi-

tional lecture methodologies that assist the student in building on previous learning to become a knowledgeable future health professional. We believe that, when strategically applied, both methodologies - active learning and passive learning - are useful for teaching and for the learning process of medical school students.

In view of what has been presented here, based on our experience in a medicine course at a private education institution in Brazil, we agree with and share the ideas proposed by Michael (2006). There is evidence that active learning, student-centered approaches to teaching physiology work, and they work better than more passive approaches. There is no single definitive experiment to prove this, nor can there be given the complexity of the problem, but the growing number of examples makes the argument compelling. Therefore, we should all begin to reform our teaching, employing those particular approaches to fostering active learning that match the needs of our students, our particular courses, and our own teaching styles and personalities. There are plenty of options from which we can choose, so there is no reason not to start. This will mean that we too become learners in the classroom.

As scientists, we would never think of writing a grant proposal without a thorough knowledge of the relevant literature, nor would we go into the laboratory to actually do an experiment without knowing about the most current methodologies being employed in the field (Michael, 2001). Yet, all too often, when we go into the classroom to teach, we assume that nothing more than our experiences as students and teachers are required to be a competent teacher. However, this approach makes more sense in the classroom than it would in the laboratory (Michael, 2006).

DISCLOSURES

The authors declare no conflicts of interest, financial or otherwise.

AUTHOR CONTRIBUTIONS

Author contributions: CMC, LBL, SMBM, VNGD conception and design the memory game; LHM drafted manuscript; CMC, LBL, SMBM, VNGD approved final version of manuscript; LHM edited and revised manuscript.

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